National Aeronautics and
Space Administration

FY 1994
SAFETY PROGRAM
STATUS REPORT

NASA Safety and Risk Management Division
Office of Safety and Mission Assurance
Washington, D.C. 20546

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SAFETY PROGRAM OVERVIEW

During FY 1994, the NASA Safety and Risk Management Division continued efforts to enhance the quality and productivity of its safety oversight function. Initiatives in areas such as training, risk management, safety assurance, operational safety, and safety information systems have contributed to the safety and success of activities throughout the Agency.

The Safety and Risk Management Division continued to sponsor development of a centralized intra-agency safety training program. A major accomplishment in this area is the continued success of the NASA Safety Training Center (NSTC). This facility is located at the Johnson Space Center (JSC) and provides quality NASA-specific safety training at lower cost. The NSTC trained over 1,200 students in FY 1994 on a broad range of safety-related topics. One of the major efforts for FY 1994 was a second offering of the Certified Safety Professional Review Course to over 120 NASA and contractor personnel. This course provides a comprehensive review of the skills and knowledge that well-rounded safety professionals must possess to qualify for professional certification. This course was first given in 1992 and resulted in a number of people at each NASA Installation going on to take the safety certification tests. The course was revised for 1994 with improved presentation and course material based on input from the previous students. The program is a key part of continuing efforts to enhance the total quality of NASA's safety personnel.

The Safety and Risk Management Division sponsored the development of numerous new courses for presentation by the NSTC in FY 1994. They included: Occupational Ergonomics, Mishap Investigation Refresher, Fire Protection - Theory and Practice, Payload Safety Review Process, Shuttle Mishap Investigation Team Training, Overhead Crane and Materials Handling Safety, Aircraft Accident Investigation, and Fall Protection.

NASA Headquarters is working to fully institutionalize safety into all programs and processes through the development and implementation of a safety career training program. This program is designed to enhance the career scope and upward mobility of NASA safety professionals and program and project managers. The program will ensure that NASA management has the necessary safety skills with emphasis on application to day-to-day responsibilities.

The Safety and Risk Management Division continued its participation with the Federal Advisory Committee for Occupational Safety and Health (FACOSH) to ensure NASA remains abreast of all new regulations, initiatives, issues, etc. NASA continued work with the FACOSH Training Subcommittee to solve the problem of providing effective training to employees at reasonable cost. FY 1994 saw further implementation of NASA's agreement with the Occupational Safety and Health Administration (OSHA) that allows OSHA training courses to be presented by the NSTC. A major event in 1994 was the presentation of the OSHA Electrical Safety Course over NASA's Video Teleconference System (ViTS). Mr. Joseph A. Dear, Assistant Secretary, U.S. Department of Labor, OSHA, was present to express his support for the combined training effort and to witness use of the ViTS. The NSTC coupled with the ViTS has proven to be a powerful combination for providing high quality training to large numbers of students in a most cost

effective manner. NASA presentations of OSHA courses are being made available to other government organizations with similar training needs on a seat available basis.

The Safety and Risk Management Division sponsored a number of research and development activities conducted at Headquarters and various NASA Centers designed to address unique NASA safety needs:

The Lewis Research (LeRC) Center continued efforts to develop a Process Safety Management Program in compliance with new OSHA regulations. Program documentation (standards, operating procedures, etc.) will provide the basis for an Agencywide program.

The Goddard Space Flight Center (GSFC) continued its research to develop effective fire protection for high bay structures. FY 1994 activities included the study of smoke movement and smoke layer development in high bays.

A parametric fire suppression study is being sponsored at the White Sands Test Facility (WSTF). The goal is to define a set of fire suppression deluge water demand curves for varying oxygen percentages, pressures, and materials.

The Stennis Space Center (SSC) is being sponsored in the development of an improved electro-optical Hydrogen fire sensor capable of eliminating false alarms due to light sources such as welding operations, lightning, and reflections from flare stacks. Stennis is also testing the feasibility of a low cost hand-held Hydrogen fire imager for personnel to carry for safe entering and exiting of Hydrogen handling areas.

GSFC is developing a Facility System Safety Handbook to provide comprehensive procedures for standardized facility system safety engineering techniques to be used throughout NASA.

Ames Research Center (ARC) and SSC are working jointly to develop an aerial reconnaissance system that would provide responsible officials with real-time damage assessment data in the event of an emergency/disaster. This effort is being coordinated with the Federal Emergency Management Agency (FEMA). The goal is to utilize NASA technology to meet a critical national need for rapid-response disaster assessment.

A laboratory risk evaluation program is being sponsored at the Langley Research Center (LaRC) to enhance capabilities in monitoring the safety aspects of laboratory operations and resolving unsafe practices. Also, to increase safety awareness at the operator level and establish a separate Configuration Management Program for laboratory-type facilities.

SSC completed the development of NASA lifting device database software in FY 1994. The software was distributed to all NASA Centers for use by safety and engineering personnel in tracking and retaining pertinent data relating to the safe operation of lifting devices.

NASA continued to work with the Air Force on a joint test and evaluation program for graphite/epoxy composite overwrapped pressure vessels. This relatively new technology is becoming more widely used in the aerospace industry due to the potential for weight savings. There are a number of unique safety concerns for personnel working with and around these vessels. The purpose of the research program is to better define the design, handling, and transportation requirements necessary to use these vessels safely.

NASA continued its initiatives to control trends, major causes or sources of fatalities and lost time disabilities, and to lower overall compensation costs. The Safety and Risk Management Division sets annual lost time injury/illness frequency rate goals for each Center. The goals are based on a number of parameters including previous performance as compared to the Center's own past record and to the overall Agency rate, improvement desired, and projected worker hours. This effort is part of an overall safety motivation program that strives to continually reduce injuries in the workplace.

The Safety and Risk Management Division participated on NASA's "Reinvention of Government" Team to ensure safety concerns are properly addressed and program changes yield positive impacts on NASA's safety program.

The Safety and Risk Management Division continued to participate on various Joint Army, Navy, NASA, Air Force (JANNAF) subcommittees involved in the development of standards/codes and resolving issues in the areas of safety, explosives, propellants, and hazardous material handling and storage operations.

NASA participated in the National Highway Traffic Safety Administration Drunk and Drugged Driver Awareness Campaign and instituted the Department of Transportation's "Four Seasons Approach" to traffic safety.

NASA continued efforts at JSC to participate in OSHA's Voluntary Protection Programs (VPPs). A thorough review of JSC's safety and health program was conducted. JSC is refining its program to qualify for VPP participation.

A Continuous Improvement Team was established at the Marshall Space Flight Center (MSFC) to work on improvements to NASA mishap reporting and investigation. The team drafted a new NASA Management Instruction as well as an updated chapter and new volume for the NASA Safety Policy and Requirements Document. These documents outline the team's recommendations for an improved system.

The Safety and Risk Management Division prepared and published a NASA Operational Safety Management Reference Book. The purpose is to provide easy reference to elements of NASA's Operational Safety Program including Occupational Safety and Health. This three volume set is a compilation of Headquarters policy and requirements documents, standards, and other pertinent information that NASA safety personnel should have readily available in order to carry out their responsibilities.

NHB 1700.1 (V1-B), "NASA Safety Policy and Requirements Document," dated June 1993, is the central Agency document containing safety policy and requirements that define the NASA Safety Program. It was published contingent on an 18 month trial period to allow the Centers an opportunity to assess the impact of the document on their programs. The trial period included all of FY 1994. Center comments have resulted in some minor policy changes and a proposed rewrite to the chapter on mishap investigation.

NASA continued development of its Emergency Preparedness Program. All NASA Centers developed programs designed to address their unique needs and to implement the NASA Emergency Preparedness Plan. NASA Headquarters established a requirement for the Centers to perform special self evaluations of their emergency preparedness programs and report the findings to Headquarters by January 1995. The Safety and Risk Management Division sponsored an Emergency Preparedness Coordinators Meeting at ARC, March 23 -24, 1994. Specific meeting topics included Center program status reports, procurement of portable command units, NASA aerial reconnaissance capabilities, and lessons learned from the Northridge Earthquake. In addition, an Emergency Information System (EIS) for Windows Users Workshop was presented that was designed to enhance the skills of NASA and contractor personnel responsible for operating the EIS computerized emergency planning and response tool. Headquarters funded NASA Center procurement of mobile emergency response command units during FY 1994. These suitcase size units include a Note Book P.C., facsimile machine, bubble jet printer, cellular phone, hand held scanner, and 35 millimeter camera. Funding was also provided to each NASA Center for the purchase of EIS software.

NASA continued its active participation in the Federal Response Program and provided extensive aerial reconnaissance support in response to the Northridge Earthquake and the wild fires in California. The NASA Emergency Preparedness Program is actively participating with the Federal Emergency Management Agency in their "RESPONSE 95" exercise. Efforts during FY 1994 revolved around the design and preparations for this national emergency response exercise scheduled for May 1995.

The Headquarters Hazardous Substances Internal Coordinating Committee continued to provide a forum for interdisciplinary discussion among all Headquarters staff concerned with the health, safety, storage, and transportation of hazardous materials, and the environmental exposure of the NASA workforce. The committee was active in screening and assessing the impact of new and proposed regulatory requirements and the need for related training.

The NASA Safety and Risk Management Division continued to sponsor periodic Safety Directors' Steering Committee meetings. The meetings provide a forum for the exchange of information and the discussion of safety-related issues. The FY 1994 meeting was held at the Marshall Space Flight Center February 9, 1994. This meeting focused on the introduction of Mr. James D, Lloyd, newly confirmed Director, Safety and Risk Management Division, and program reorganizations, initiatives, and objectives. Specific topics included streamlining requirements documents, NASA's Mishap Reporting and Investigation Program, Safety Training Program, Risk Management/Assessment Program, and Lessons Learned Program.

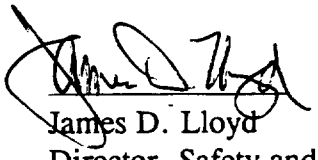
During FY 1994 NASA supported the Forty-Eighth Annual Federal Safety and Health Conference in Chicago, Illinois. NASA was represented by three Field Installations and the Headquarters Safety and Risk Management Division. Headquarters prepared a compilation of presentations and handouts from the conference that was distribution throughout NASA for personnel who were unable to attend.

The Safety and Risk Management Division sponsored a Fire Protection Meeting at ARC, May 18 - 20, 1994, in conjunction with the National Fire Protection Association's Annual Meeting held in San Francisco, California. The purpose of the meeting was to review the fire protection programs at each NASA Center to establish Agency needs; resolve policy and technical issues related to NSS 1740.11, "NASA Safety Standard for Fire Protection"; and maintain a high level of emphasis on the overall NASA Fire Protection Program. Specific topics included identification of firefighting equipment needs, emergency preparedness coordination, use of the Emergency Information System software, functional management self-assessments, and lessons learned.

The Safety and Risk Management Division sponsored a NASA/DoD Pressure System Seminar at the U.S. Air Force Arnold Engineering Development Center, October 19 - 21, 1993. The purpose of this biennial event is to discuss the status of the Agencywide Pressure System Safety Program and to provide a forum for the exchange of information on pressure system related issues. This was the first time this event was held at other than a NASA Installation and marks the first step in establishing the Seminar as a forum open to all government and industry.

The Safety and Risk Management Division continued active involvement in the design and implementation of NASA's Functional Management Program to ensure proper assessment of NASA's safety programs. Under this program, NASA Centers are responsible for conducting self assessments of their safety activities. Headquarters may assist with Center self assessments and may conduct its own spot checks of an installation. The Safety and Risk Management Division published a Functional Management questionnaire based on 29 CFR 1960 and unique NASA requirements designed to assist the NASA Centers and Field Installations with self assessments of their safety programs. During FY 1994, The Safety and Risk Management Division participated in program assessments/spot checks at LaRC and Dryden Flight Research Center (DFRC), assisted GSFC with their review of NASA's Space Launch Complex at the Vandenberg Air Force Base, and conducted a program assistance visit at the Jet Propulsion Laboratory (JPL).

NASA will continue to strive for maximum safety awareness and excellence in all activities. The Centers and Headquarters will continue to work together as a team to maintain an emphasis on safety.



James D. Lloyd
Director, Safety and Risk Management Division

FY 1994 NASA SAFETY STATISTICS

Fatalities	0
NASA Safety Reportable Lost Time Injuries/Illnesses	92
Costs	
Lost Wages	$138,469
Chargeback Billing	$6,700,000
Material Losses	* $2,949,883
Total Losses	* $9,788,352

* Does not include damage to Rocketdyne facilities in Canoga Park, California, due to the Northridge Earthquake (natural phenomenon). NASA repair costs were estimated at $10 million. See Page 34 for details.

Information on injuries/illnesses and material losses was obtained from the NASA Mishap Reporting/Corrective Action System (MR/CAS). Lost wages and chargeback billing figures are from the Office of Workers' Compensation Programs (OWCP).

NASA OCCUPATIONAL INJURY/ILLNESS RECORD

As defined by OSHA, a recordable (i.e., compensable) lost time case is a work-related incident that results in either a nonfatal, traumatic injury that causes loss of time from work or disability beyond the day or shift when the injury occurred, or a nonfatal illness/disease that causes loss of time from work or disability at any time. NASA Safety organizations adhere to the OSHA reporting guidelines with some exceptions. For example, NASA Safety does not consider restricted duty or time taken for medical treatment to be lost time. Also, instances of injuries sustained during recreational activities or in parking lots during non-work-related activities are not included in the MR/CAS.

Table 1 shows the FY 1994 NASA Safety reportable injury/illness statistics for Federal employees at NASA Centers. The NASA Safety and Risk Management Division calculates injury/illness frequency rates based on the actual hours worked by each employee. The overall lost time frequency rate of 0.43 for NASA Federal employees is a 23% Increase from the FY 1993 rate of 0.35.

TABLE 1. NASA SAFETY REPORTABLE LOST TIME INJURIES/ILLNESSES BY INSTALLATION
ANNUAL REPORT FY 1994

	Average No. of Employees	Hours Worked	Lost Time Cases			
			No. Days	No. Cases	Freq.* Rate	1994 Goal
ARC	2,021	3,498,859	203	19	1.08	0.51
DFRC	446	927,680	5	1	0.22	0.74
GSFC/WFF	3,836	6,664,299	144	14	0.42	0.36
HQ	2,135	5,076,237	148	10	0.39	0.54
JSC/WSTF	3,984	5,659,512	57	8	0.28	0.36
KSC	2,510	4,583,558	44	11	0.48	0.34
LARC	2,910	5,101,241	70	5	0.20	0.34
LERC	2,424	4,622,094	53	14	0.61	0.40
MSFC	3,473	6,287,498	108	9	0.29	0.42
SSC	215	399,386	10	1	0.50	0.34
NASA	23,954	42,820,364	842	92	0.43	0.40
1993	25,196	45,697,714	659	81	0.35	0.40

* Lost Time frequency rate = Number of lost workday cases per 200,000 hours worked.

Figure 1 shows how the FY 1994 NASA Safety reportable lost time injury/illness frequency rates for Federal employees at NASA Centers compare to the individual Center goals set by the Safety and Risk Management Division and the overall NASA goal of 0.40. Although the Agency did not meet its overall goal, 5 out of 10 NASA Centers did meet their individual goal.

Figure 2 plots the NASA Safety reportable lost time frequency rates for the last 10 years. The plot shows a relatively narrow range of rates during this period, from 0.35 to 0.48. The 1994 Agency rate of 0.43 was an average performance compared to recent years.

Figure 3 compares the FY 1994 NASA Safety reportable lost time frequency rates of NASA Federal employees at each Center with the previous year's rate and an average rate for the previous 3 years (FY 1991 - FY 1993). 1994 was an outstanding year for 5 out of 10 NASA Centers relative to their recent past performance.

Approximately 99% of NASA's FY 1994 lost time cases were injuries rather than illnesses. See Figure 4 for a breakdown of the major causes of lost time injuries Agencywide for FY 1994. Slips, trips, and falls were the number one cause of lost time injury (40%) followed by overexertion while lifting or moving objects (29%). Figure 5 shows the percentage of lost time injury at each Center attributed to these two causes. Figure 6 provides a breakdown of the injured body parts. Back injuries were the most prevalent. One third of all NASA's FY 1994 lost time injuries were attributed to back injuries.

NASA LOST TIME RATES VS. GOALS
FY 1994

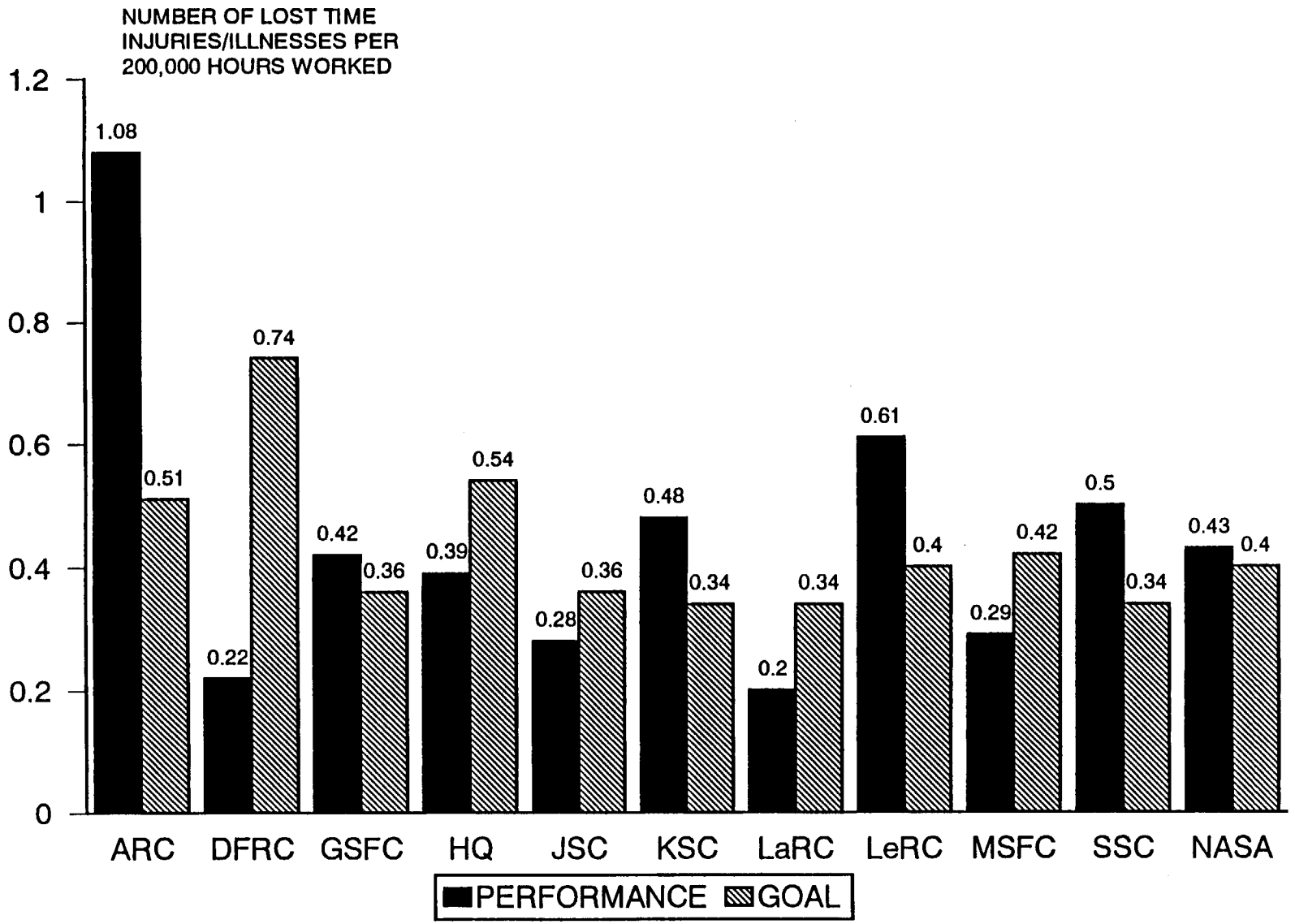


Figure 1

NASA LOST TIME INJURY/ILLNESS RATES

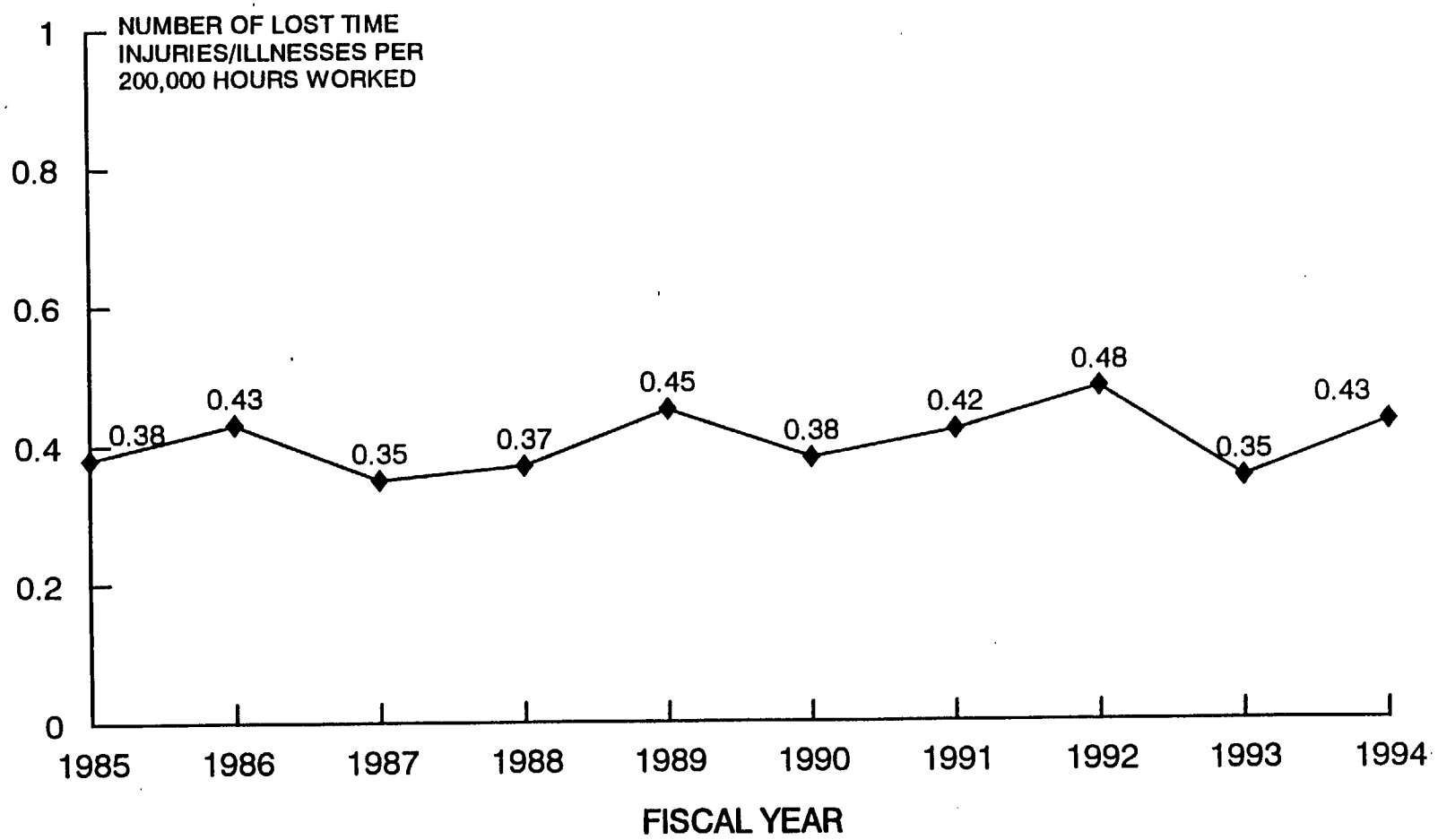


Figure 2

NASA CENTERS
LOST TIME INJURY/ILLNESS RATE HISTORY

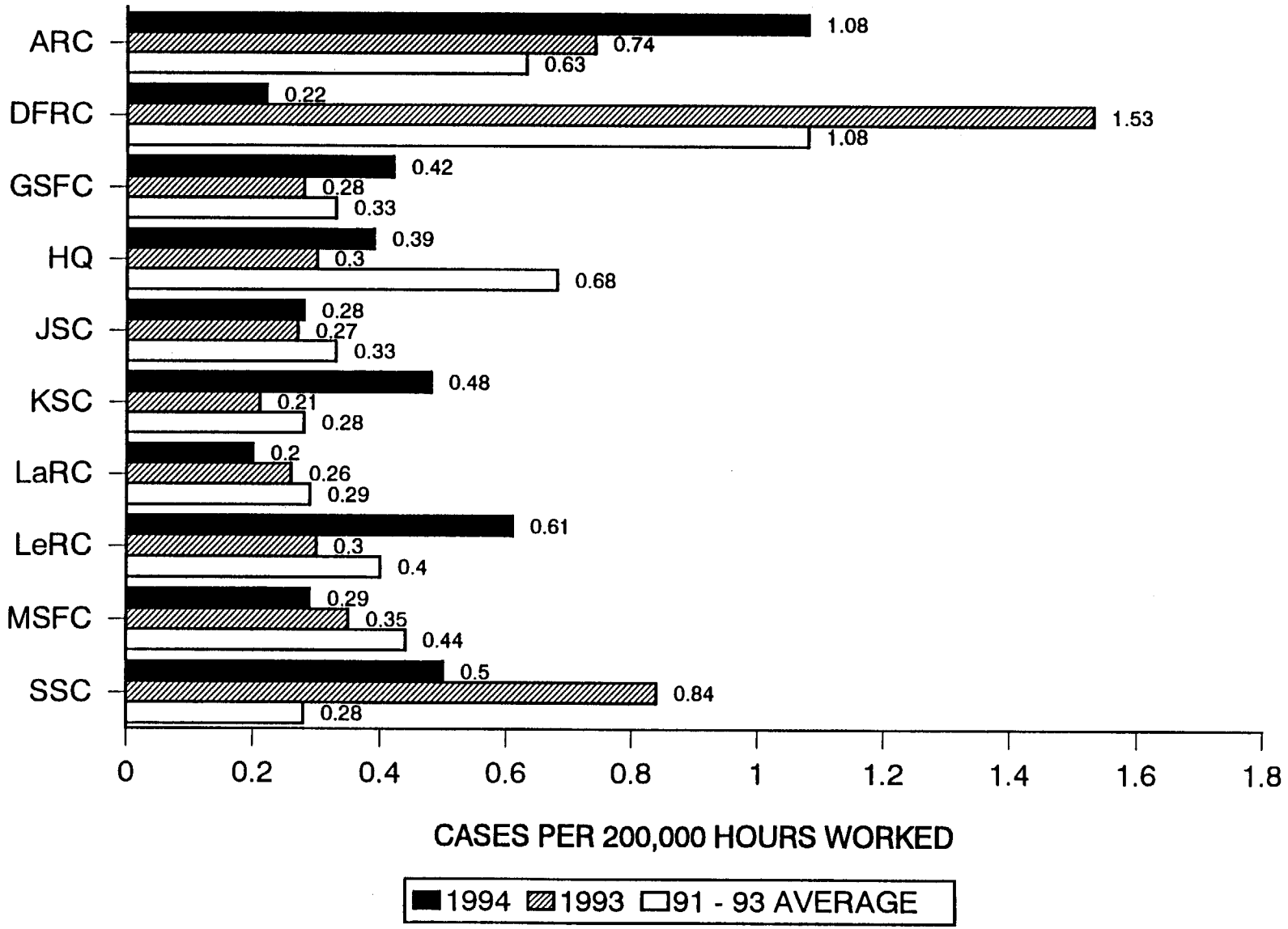


Figure 3

FY 1994 NASA LOST TIME INJURY CAUSES

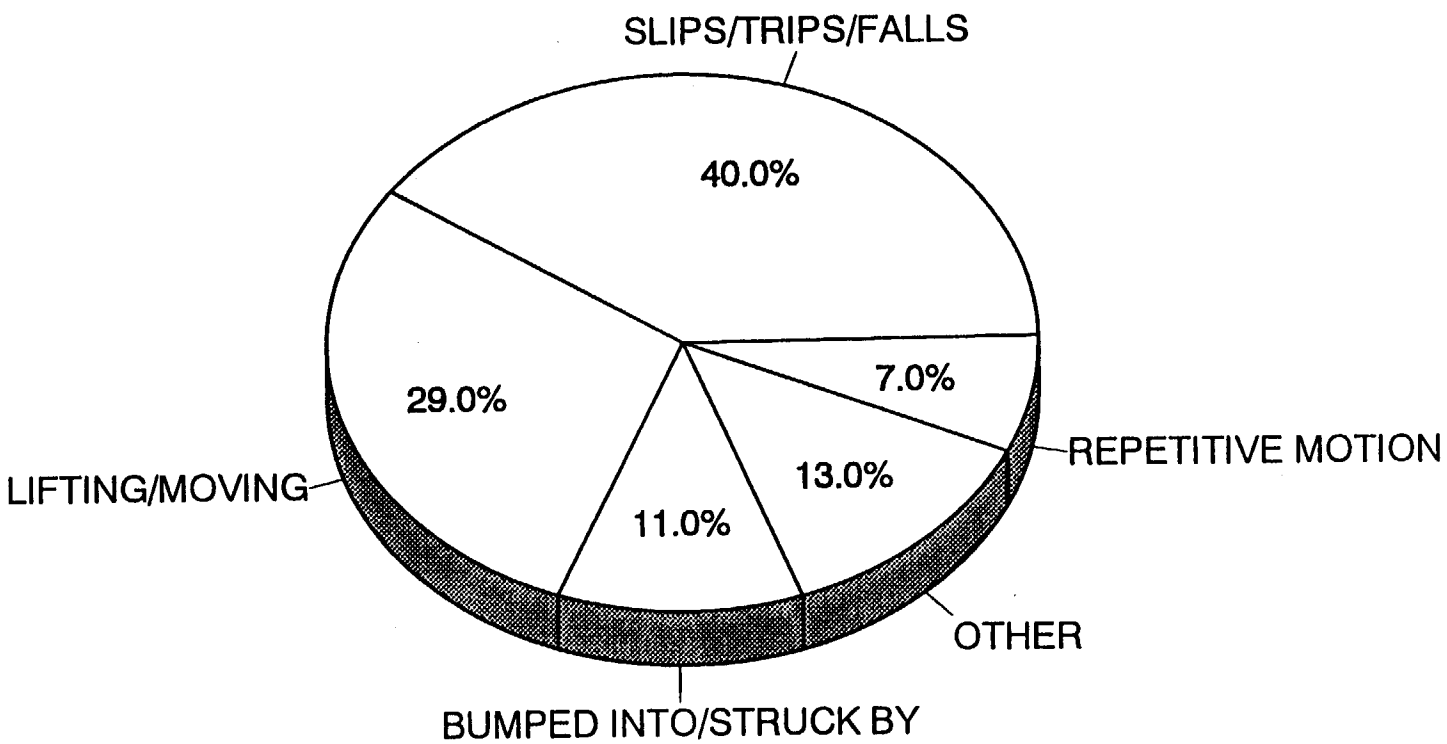


Figure 4

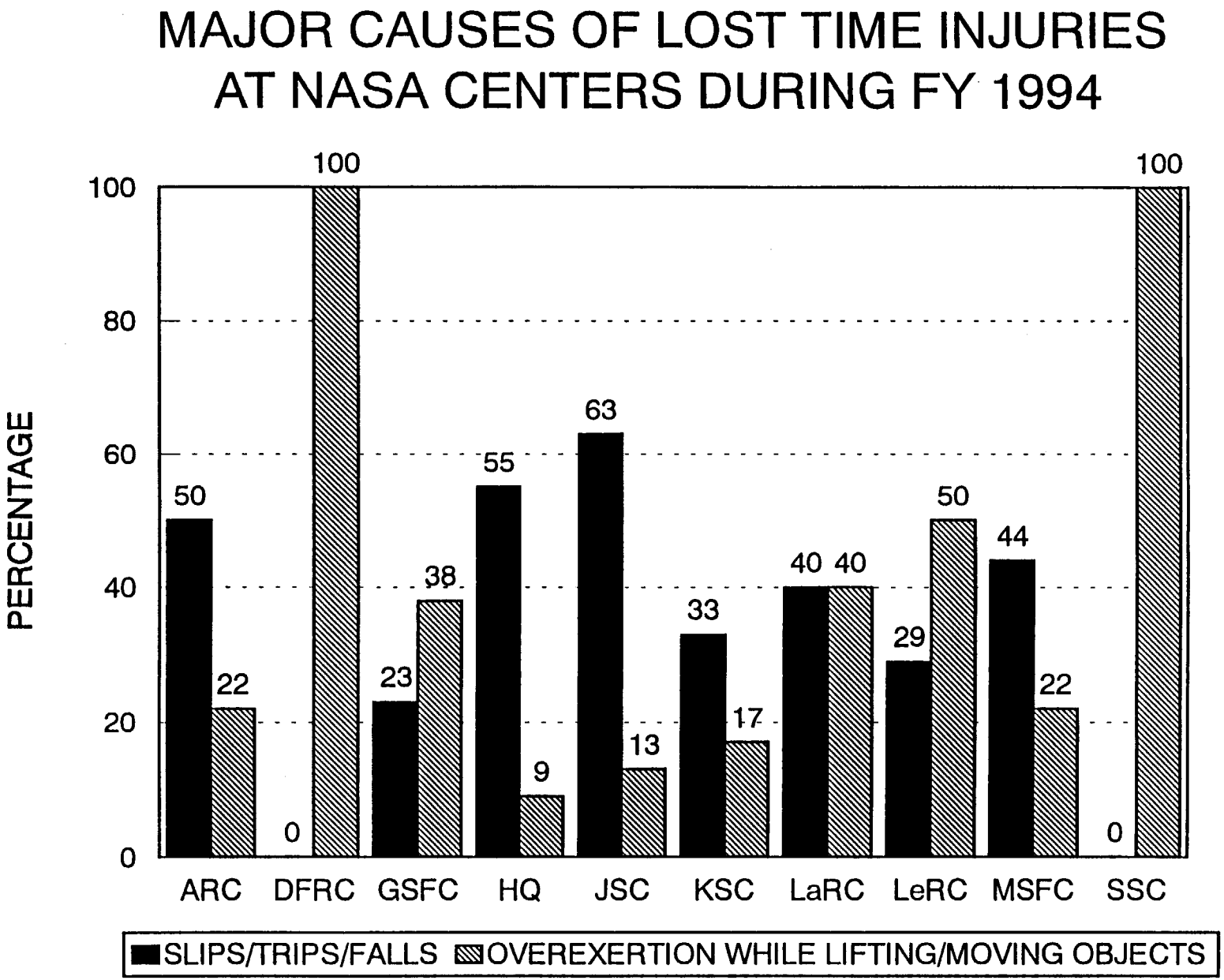

MAJOR CAUSES OF LOST TIME INJURIES
AT NASA CENTERS DURING FY 1994
PERCENTAGE
100
80
60
40
20
0
50
22
0
100
23
38
55
9
63
13
33
17
40
40
29
50
44
22
0
100
ARC
DFRC
GSFC
HQ
JSC
KSC
LaRC
LeRC
MSFC
SSC
SLIPS/TRIPS/FALLS
OVEREXERTION WHILE LIFTING/MOVING OBJECTS

Figure 5

FY 1994 NASA LOST TIME INJURY BODY PARTS AFFECTED

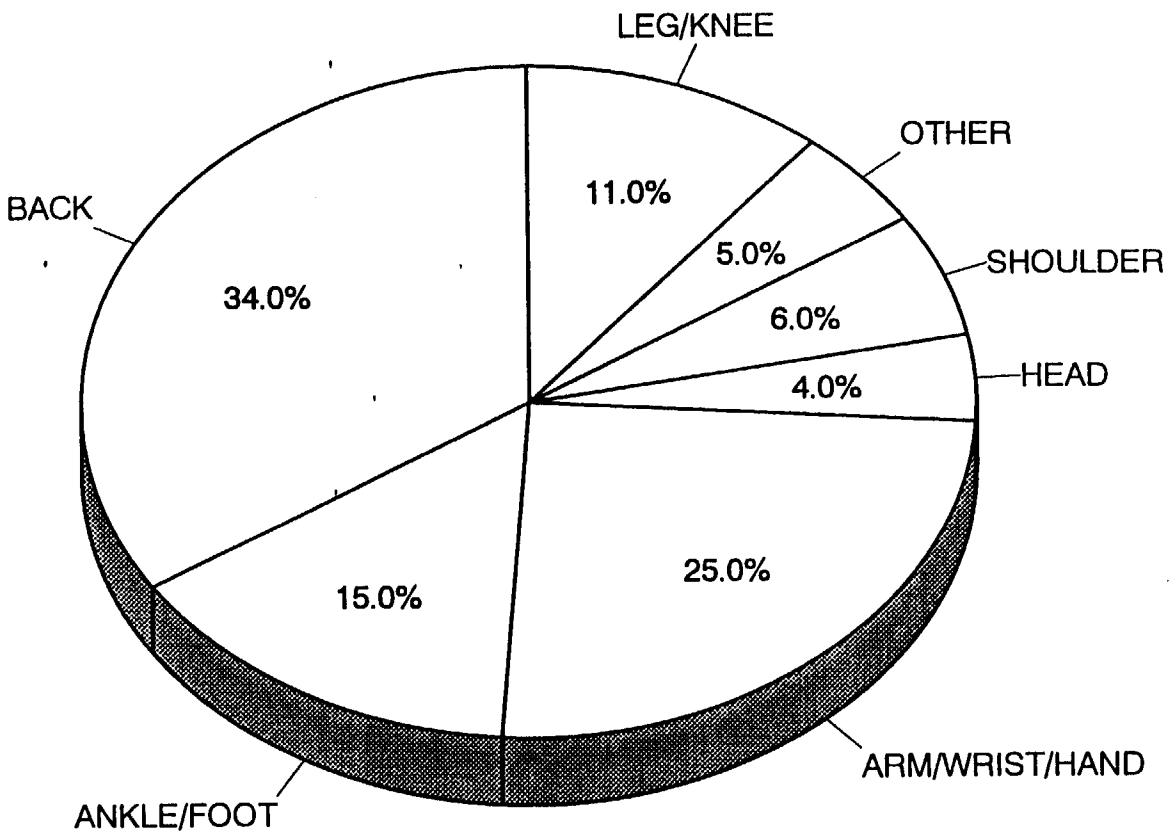


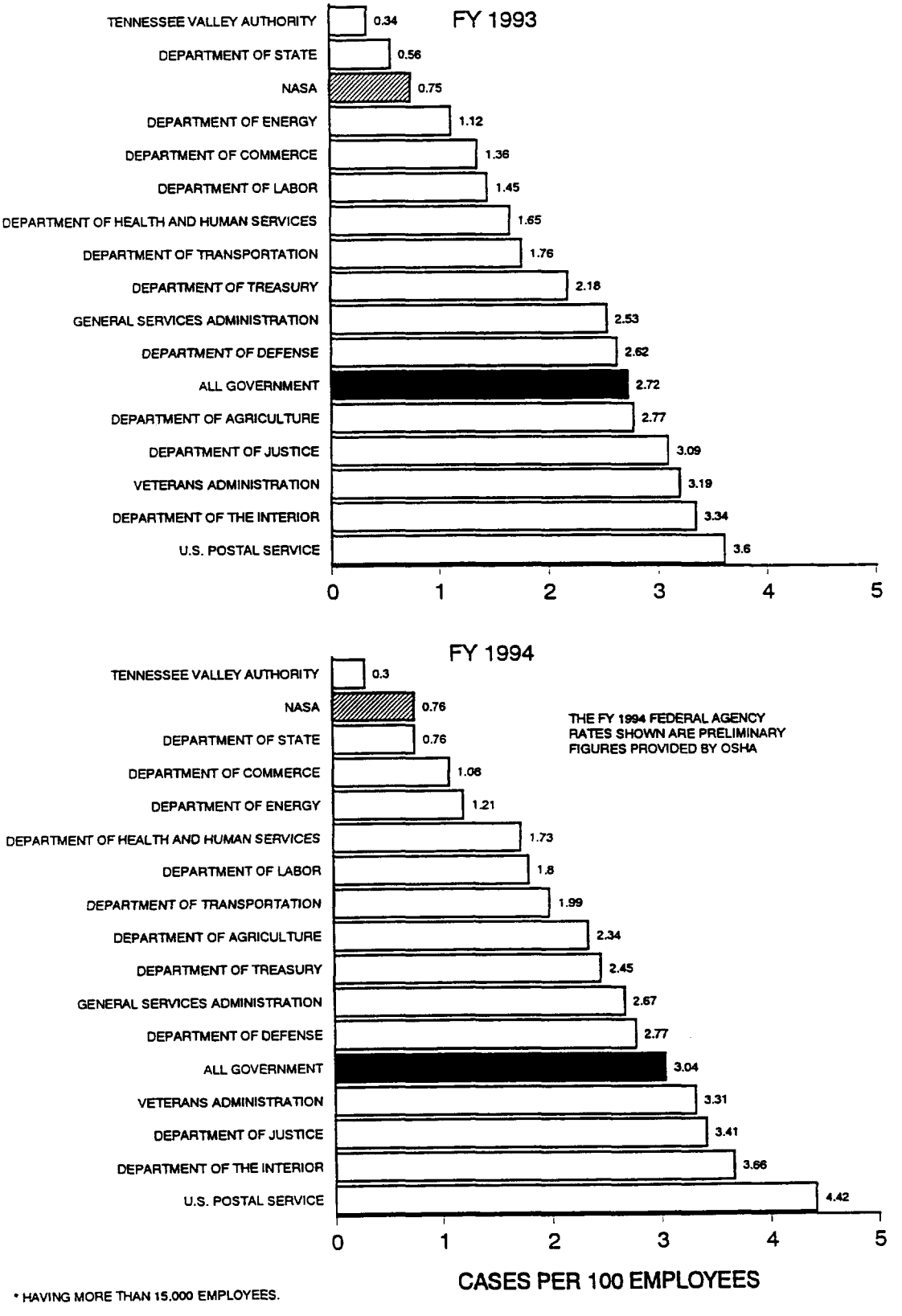
Figure 6

Comparison of NASA's injury/illness performance to that of other Government agencies and private industries can be made using the injury/illness incidence rates published by the Department of Labor. Figures 7 and 8 reflect these rates, which are based on OWCP data and determined according to the number of injury/illness cases per 100 employees. The incidence rate for NASA is usually higher than the frequency rate calculated by the NASA Safety and Risk Management Division. This is due to inherent differences in the two formulas and variations in the OWCP data. (OWCP tracks the number of claims made on OSHA recordable injuries and illnesses. It is possible for more than one claim to be made as the result of a given injury or illness.)

Figure 7 illustrates the relative position of NASA's lost time injury/illness performance compared to that of other Federal agencies having more than 15,000 employees in FY 1993 and FY 1994. Within this group of Federal agencies, NASA has ranked second or third lowest for the last ten years.

Figure 8 compares NASA's lost time injury/illness performance for the last 10 years against the total for all Federal agencies and select private sector industries. NASA's rates have been consistently lower than the total for all Federal Government and the private sector. The most recent statistics available from the Department of Labor for the private sector are for FY 1993.

LOST TIME INJURY/ILLNESS RATES IN SELECTED FEDERAL AGENCIES*



* HAVING MORE THAN 15,000 EMPLOYEES.

Figure 7

LOST TIME OCCUPATIONAL INJURY/ILLNESS RATES
PRIVATE SECTOR-ALL FEDERAL AGENCIES-NASA

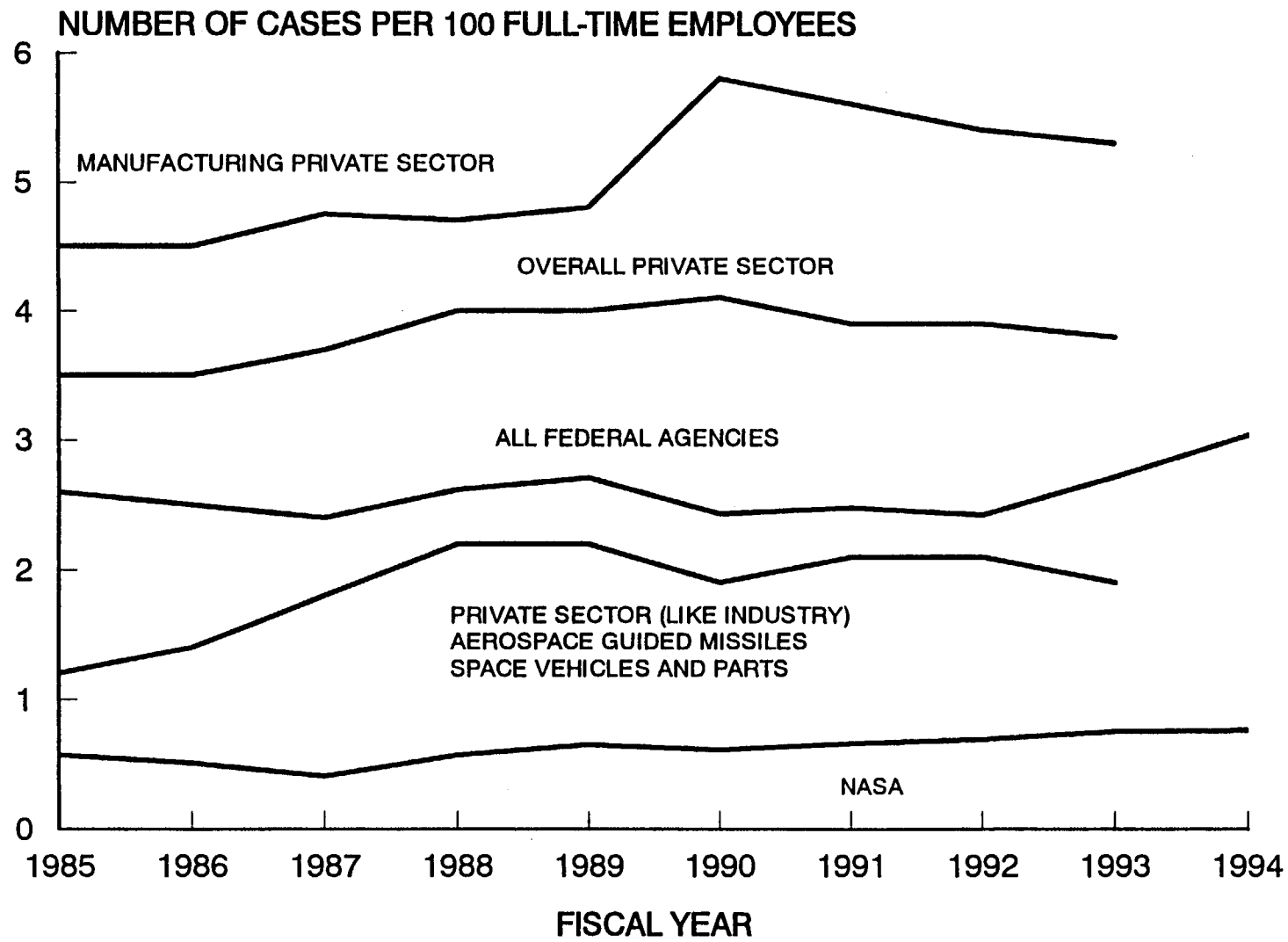


Figure 8

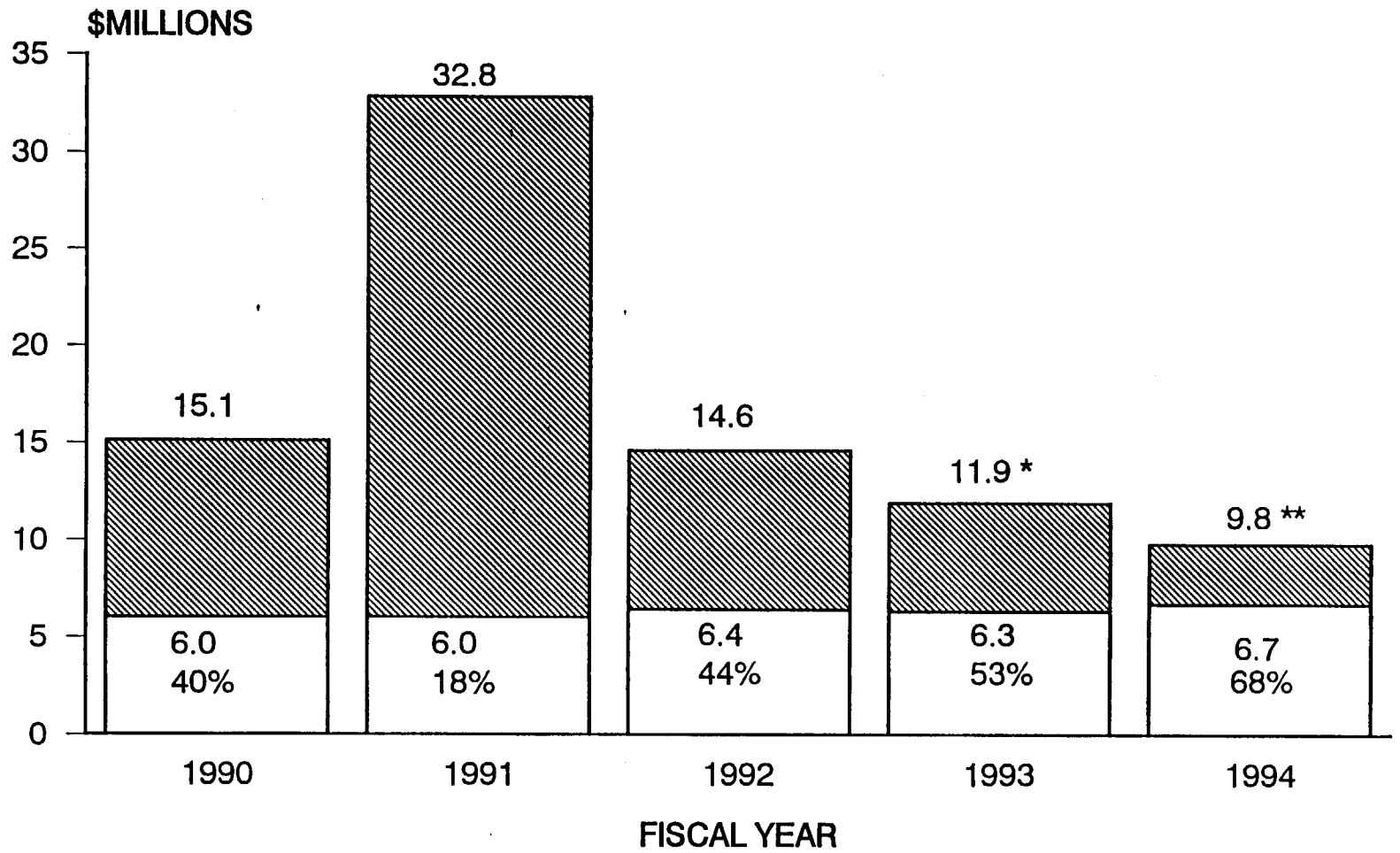
CHARGEBACK BILLING

Chargeback is defined by OSHA as a system under which the Department of Labor pays compensation and medical costs attributed to injuries that occurred after December 1, 1960, and then bills the agency that employed the individual who received compensation or benefits. This is a direct loss to NASA's operating budget. In any given year, most of the chargeback billing is a result of illnesses and injuries that occurred in previous years.

Figure 9 presents a 5-year history of NASA's total losses from chargeback billing and all other mishap and injury-related costs. These costs include lost wages (continuation of pay) as well as damage to or loss of NASA property in excess of $1,000. Of the $9.8 million loss for FY 1994, $6.7 million, or 68%, was paid out in chargeback billing costs.

Figure 10 illustrates the trend of chargeback billing in the Federal Government and NASA for the last 10 years. The Federal Government's chargeback billing costs have continued to rise each year with the sharpest increases occurring since 1988. From 1988 to 1994 the chargeback billing costs for all Federal Agencies increased by 65% from $1.1 billion to $1.81 billion. NASA's chargeback billing costs stabilized at around $5 million annually during the 1980's but has recently begun to increase as well. In comparison, NASA's chargeback billing costs have increased 34% since 1988. In general, the spiraling cost of health care is considered to be one of the major factors in the rising trend of chargeback billing.

TOTAL COST TO NASA DUE TO MISHAPS
CHARGEBACK VS. ALL OTHER COSTS



* DOES NOT INCLUDE LOSS OF MARS OBSERVER

** DOES NOT INCLUDE EARTHQUAKE DAMAGE AT CANOGA PARK

Figure 9

HISTORY OF CHARGEBACK BILLING COSTS FOR ALL FEDERAL AGENCIES AND NASA

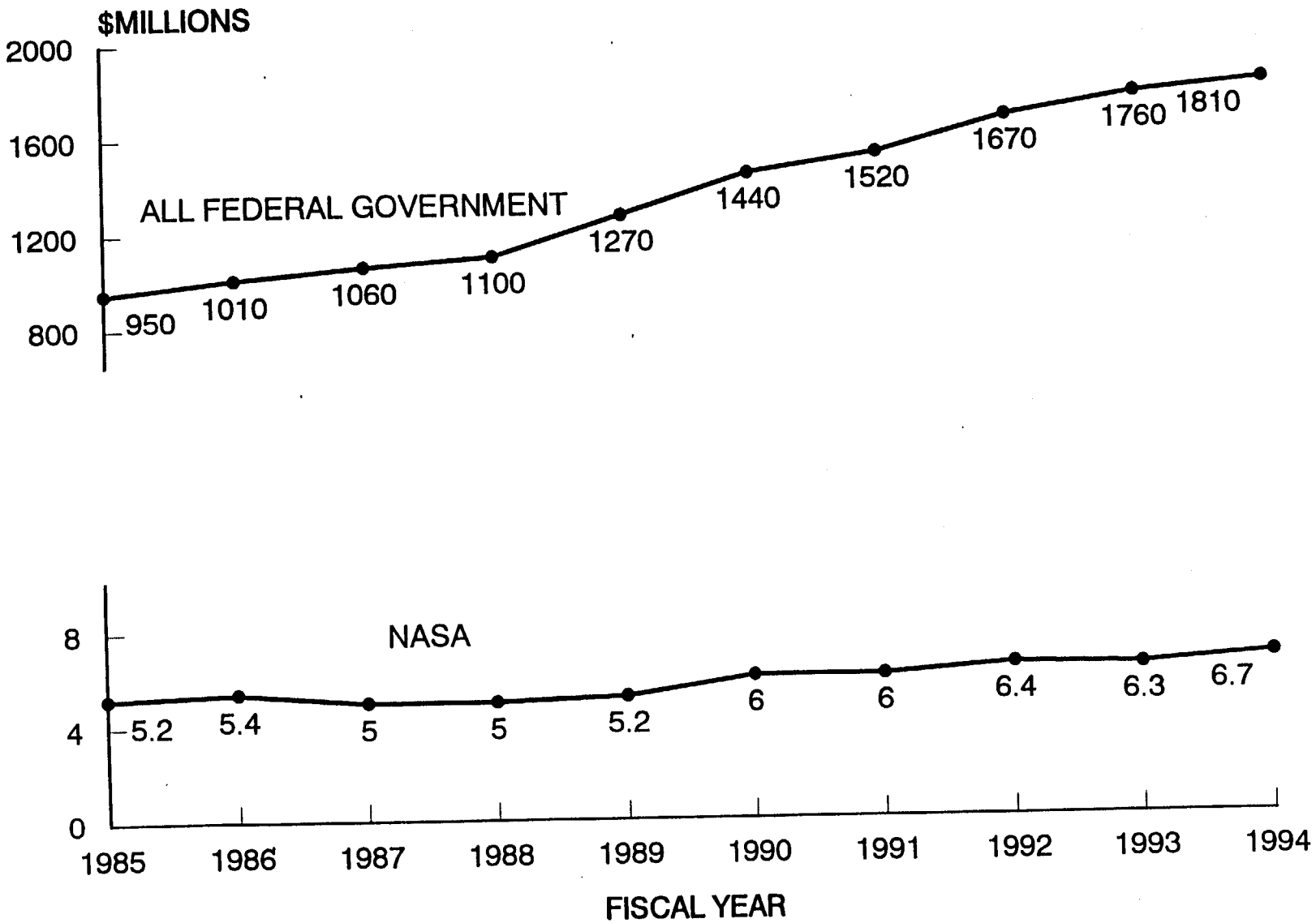


Figure 10

MATERIAL LOSSES

Tables 2A and 2B list the statistics for NASA material losses during FY 1994. Indirect costs associated with cleanup, investigation, injuries, or shutdown of operations are not included in these statistics.

Table 2A provides the number of equipment/property damage cases by equipment classification for each Center.

Table 2B provides the cost of equipment/property damage cases by equipment classification for each Center.

Figure 11 provides a percentage breakdown of equipment/property costs for FY 1994. The largest contributor was facility losses primarily due to the warehouse fire at LaRC (see Page 35 for details).

Figure 12 illustrates the total costs of material losses over the last 5 years.

Figure 13 categorizes NASA's total equipment/property costs due to mishaps for the last 5 years from 1990 to 1994. Damage/loss of flight hardware was the number one contributor to NASA's material losses during that period. Mishaps resulting in damage to NASA facilities were the second most costly. Approximately 20% of NASA's material losses during the last 5 years are attributed to facility damage.

TABLE 2A. EQUIPMENT/PROPERTY DAMAGE BY INSTALLATION - ANNUAL REPORT FY 1994
NUMBER OF CASES BY EQUIPMENT CLASSIFICATION

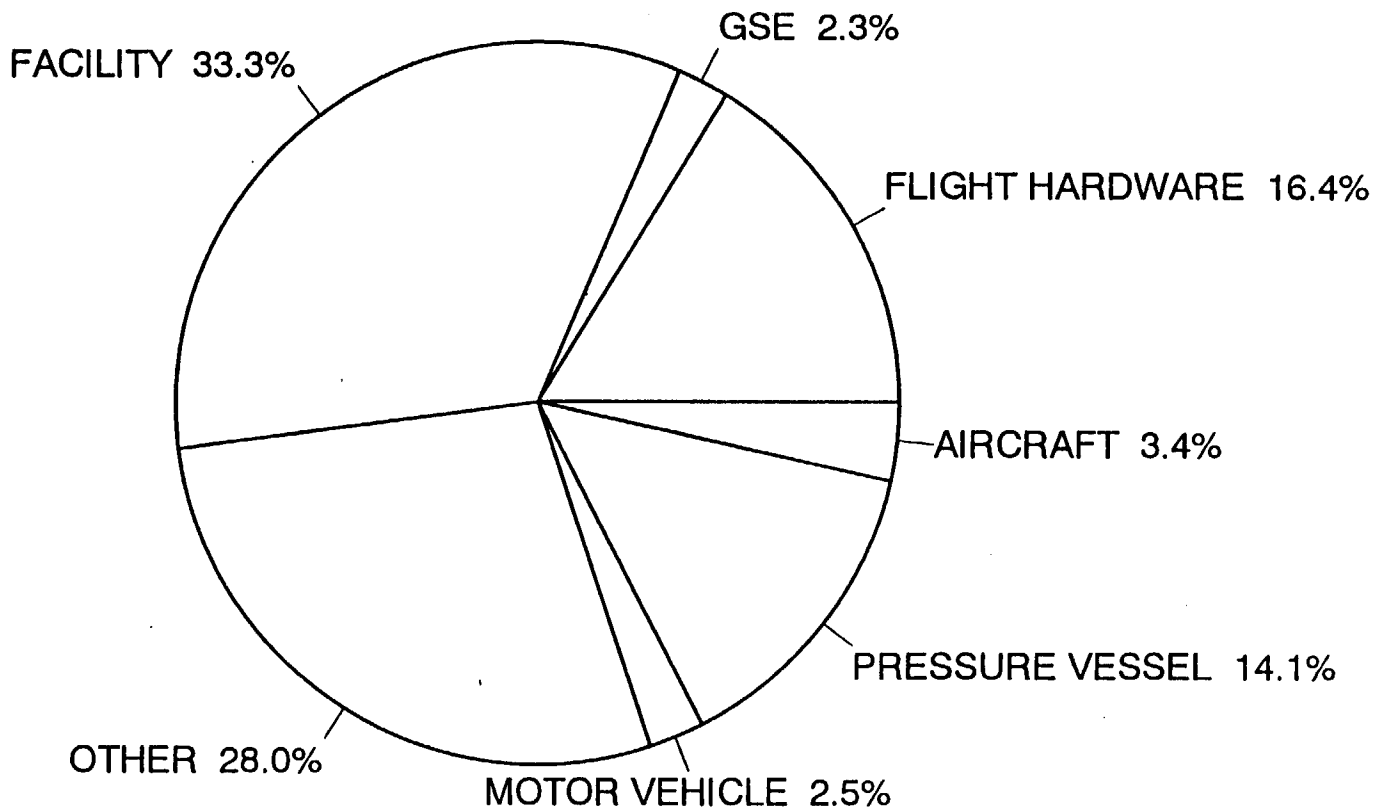
	Flight Hardware	Ground Support Equip.	Facility	Pressure Vessel	Motor Vehicle	Aircraft	Other	Total Cases
ARC	0	0	0	1	0	0	0	1
DFRC	0	0	1	0	2	0	0	3
GSFC/WFF	0	0	0	0	0	0	0	0
HQ	0	0	0	0	2	0	0	2
JPL	0	1	1	0	0	0	0	2
JSC/WSTF	1	0	5	0	0	0	5	11
KSC	3	4	0	0	7	0	1	15
LARC	0	1	2	0	0	1	2	6
LERC	0	0	3	1	2	0	9	15
MSFC	8	4	2	0	1	0	6	21
SSC	0	0	1	0	0	0	0	1
TOTAL	12	10	15	2	14	1	23	77
1993	23	6	20	2	23	5	31	110

TABLE 2B. EQUIPMENT/PROPERTY COSTS BY INSTALLATION - ANNUAL REPORT FY 1994
COST OF CASES BY EQUIPMENT CLASSIFICATION

	Flight Hardware	Ground Support Equip.	Facility	Pressure Vessel	Motor Vehicle	Aircraft	Other	Total Costs
ARC	0	0	0	414,500	0	0	0	414,500
DFRC	0	0	9,800	0	7,570	0	0	17,370
GSFC/WFF	0	0	0	0	0	0	0	0
HQ	0	0	0	0	24,777	0	0	24,777
JPL	0	5,500	150,000	0	0	0	0	155,500
JSC/WSTF	24,000	0	135,295	0	0	0	551,646	710,941
KSC	11,600	14,500	0	0	30,909	0	2,853	59,862
LARC	0	30,000	634,000	0	0	100,000	150,000	914,000
LERC	0	0	34,120	1,000	2,400	0	93,361	130,881
MSFC	447,321	18,450	14,900	0	7,300	0	31,081	519,052
SSC	0	0	3,000	0	0	0	0	3,000
TOTAL	482,921	68,450	*981,115	415,500	72,956	100,000	828,941	*2,949,883
1993	**1,799,024	39,275	3,876,658	22,000	57,131	178,516	262,355	**6,234,959

* Does not include earthquake damage at Canoga Park. See Page 34 for details.
** Does not include loss of the Mars Observer spacecraft.

FY 1994 MATERIAL LOSSES DUE TO MISHAPS
NASA TOTAL * $2,949,883



* DOES NOT INCLUDE EARTHQUAKE DAMAGE AT CANOGA PARK

Figure 11

NASA MATERIAL LOSSES DUE TO MISHAPS
TOTAL COSTS

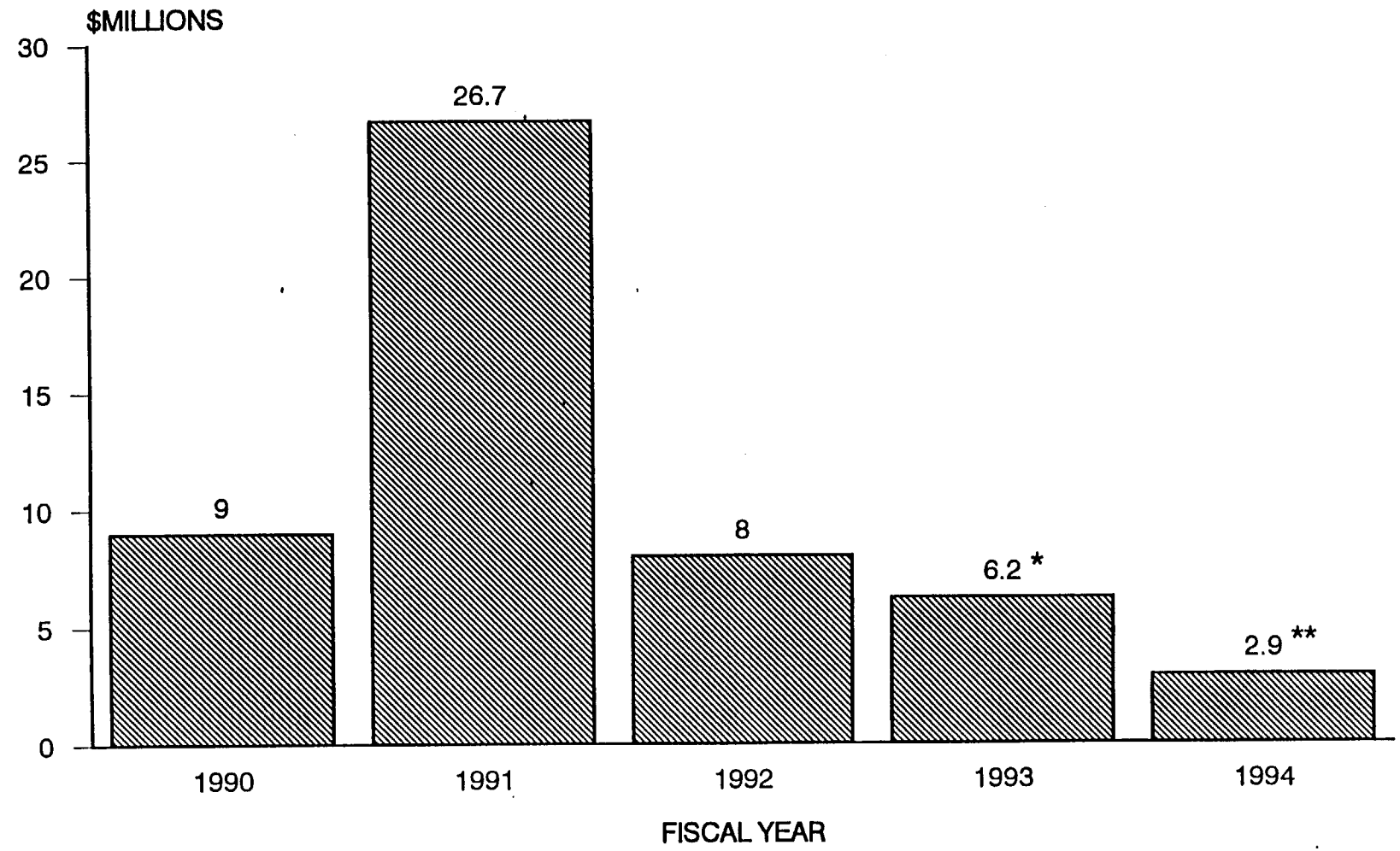
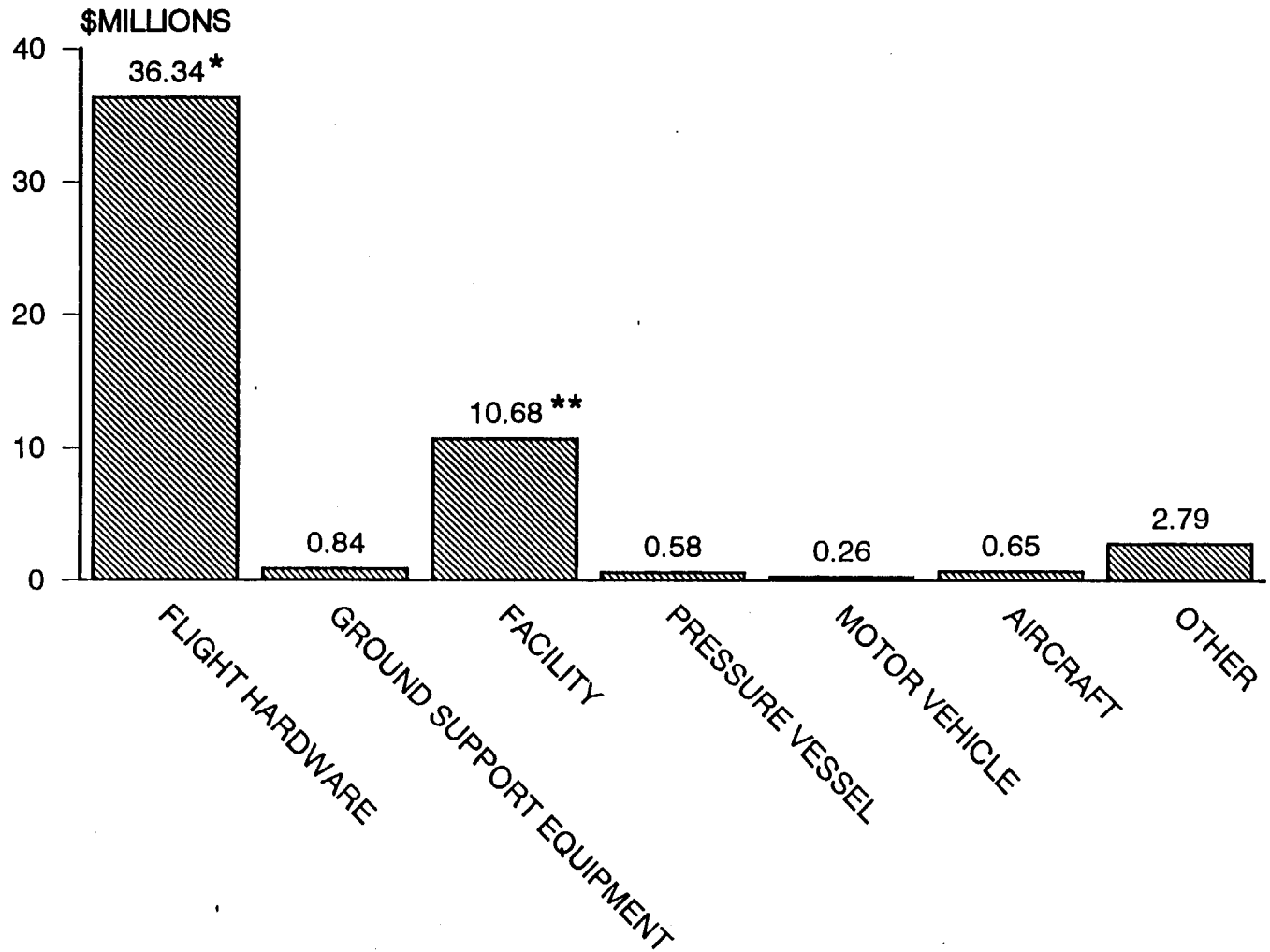


Figure 12

* DOES NOT INCLUDE LOSS OF THE MARS OBSERVER SPACECRAFT

** DOES NOT INCLUDE EARTHQUAKE DAMAGE AT CANOGA PARK

NASA MATERIAL LOSSES DUE TO MISHAPS
CATEGORY TOTALS FY 1990 - FY 1994



* DOES NOT INCLUDE LOSS OF THE MARS OBSERVER SPACECRAFT

** DOES NOT INCLUDE EARTHQUAKE DAMAGE AT CANOGA PARK

Figure 13

NASA MISHAP DEFINITIONS

The revised NASA Management Instruction for Mishap Reporting and Investigation (NMI 8621.1F), dated December 31, 1991, contains updated NASA mishap definitions. All mishaps reported in FY 1994 were categorized according to these definitions as follows:

1. **NASA MISHAP:** Any unplanned occurrence, event, or anomaly that meets one of the definitions below. Injury to a member of the public while on NASA facilities also is defined as a NASA mishap.

    a. **TYPE A MISHAP:** A mishap causing death and/or damage to equipment or property equal to or greater than $1,000,000. Mishaps resulting in damage to aircraft or space hardware, i.e., flight and ground support hardware, meeting these criteria are included. This definition also applies to a test failure if the damage was unexpected or unanticipated or if the failure is likely to have significant program impact or visibility.

    b. **TYPE B MISHAP:** A mishap resulting in permanent disability to one or more persons, or hospitalization (for other that observation) of five or more persons, and/or damage to equipment or property equal to or greater than $250,000 but less than $1,000,000. Mishaps resulting in damage to aircraft or space hardware which meet these criteria are included, as are test failures where the damage was unexpected or unanticipated.

    c. **TYPE C MISHAP:** A mishap resulting in damage to equipment or property equal to or greater than $25,000 but less than $250,000, and/or causing occupational injury or illness that results in a lost workday case. Mishaps resulting in damage to aircraft or space hardware which meet these criteria are included, as are test failures where the damage was unexpected or unanticipated.

    d. **MISSION FAILURE:** Any mishap (event) of such a serious nature that it prevents accomplishment of a majority of the primary mission objectives. A mishap of whatever intrinsic severity that, in the judgment of the Program Associate Administrator, in coordination with the Associate Administrator for Safety and Mission Quality (now Safety and Mission Assurance), prevents the achievement of primary mission objectives as described in the Mission Operations Report or equivalent document.

    e. **INCIDENT:** A mishap consisting of less than Type C severity of injury to personnel (more than first aid severity) and/or property damage equal to or greater than $1,000 but less than $25,000.

2. **NASA CONTRACTOR MISHAP:** Any mishaps as defined in Paragraphs 1a through 1e that involve only NASA contractor personnel, equipment, or facilities in support of NASA operations.

3. **IMMEDIATELY REPORTABLE MISHAPS:** All mishaps that require immediate telephonic notification to local and Headquarters safety officials. Included in this category are those mishaps defined in Paragraphs 1a through 1d and 2 with the exception of Type C injury/illness cases and incidents.

4. **CLOSE CALL:** An occurrence in which there is no injury, no significant equipment/property damage (less than $1,000), and no significant interruption of productive work, but which possesses a high potential for any of the mishaps as defined in Paragraphs 1a through 1e.

5. **OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) RECORDABLE MISHAP:** An occupational death, injury, or illness that must be recorded subject to OSHA requirements in 29 CFR Parts 1960 and 1910.

6. **COSTS:** Direct costs of repair, retest, program delays, replacement, or recovery of NASA materials including hours, material, and contract costs, but excluding indirect costs of cleanup, investigation (either by NASA, contractor, or consultant), injury, and by normal operational shutdown. Materials or equipment replaced by another organization at no cost to NASA will be calculated at "book" value. This includes those mishaps covered by insurance.

MISHAP STATISTICS

Tables 3 and 4 show the number of mishaps that were reported by the NASA Centers as having significance beyond the minor dollar losses or no-lost time injury category. These mishaps provide lessons learned for all NASA accident prevention programs.

Table 3 shows the number of fatalities experienced by NASA over the last 5 years categorized by Center. NASA experienced no mishap-related fatalities during FY 1994.

Table 4 shows the number of Type A, B, and C mishaps for each NASA Center over the last 5 years.

Figure 14 presents a 5-year history of all NASA Type A and B mishaps and a break down of Type C property damage and lost time mishaps.

Tables 5A and 5B provide a safety performance summary for FY 1994. Table 5A compares FY 1994 lost time injury/illness rates with each Center's goal and previous performance. Table 5B shows the number and type of mishaps and the cost of material losses for FY 1993 and FY 1994.

TABLE 3. FATALITIES - ANNUAL REPORT FY 1994

	1990	1991	1992	1993	1994
	N/ C/ O*	N/ C/ O	N/ C/ O	N/ C/ O	N/ C/ O
ARC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
DFRC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
GSFC/WFF	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
HQ	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
JPL	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
JSC/WSTF	0/ 0/ 0	0/ 0/ 1	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
KSC	0/ 0/ 1	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
LARC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
LERC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
MSFC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
SSC	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0
TOTAL	0/ 0/ 1	0/ 0/ 1	0/ 0/ 0	0/ 0/ 0	0/ 0/ 0

* N/ C/ O = NASA / Contractor / Other.

TABLE 4. NASA MAJOR MISHAPS BY INSTALLATION - ANNUAL REPORT FY 1994

	1990	1991	1992	1993	1994
	A/ B/ C	A/ B/ C	A/ B/ C	A/ B/ C	A/ B/ C
ARC	1/ 1/ 14	1/ 2/ 7	0/ 0/ 11	0/ 0/ 12	0/ 1/ 19
DFRC	0/ 0/ 0	0/ 0/ 5	0/ 0/ 5	0/ 0/ 9	0/ 0/ 1
GSFC/WFF	0/ 0/ 9	0/ 0/ 9	0/ 0/ 14	0/ 1/ 10	0/ 1/ 13
HQ	0/ 0/ 18	0/ 0/ 17	0/ 0/ 21	0/ 0/ 7	0/ 0/ 10
JPL	0/ 0/ 1	0/ 0/ 1	0/ 1/ 1	1/ 0/ 1	0/ 0/ 1
JSC/WSTF	0/ 0/ 12	0/ 1/ 13	0/ 0/ 15	0/ 0/ 13	0/ 1/ 9
KSC	1/ 0/ 11	1/ 0/ 8	0/ 0/ 11	0/ 0/ 8	0/ 0/ 11
LARC	0/ 0/ 8	0/ 0/ 9	0/ 0/ 9	0/ 0/ 9	0/ 1/ 9
LERC	0/ 0/ 13	0/ 0/ 11	0/ 0/ 16	0/ 1/ 9	0/ 0/ 17
MSFC	0/ 0/ 11	1/ 0/ 20	1/ 3/ 26	0/ 0/ 16	0/ 0/ 12
SSC	0/ 0/ 1	0/ 0/ 1	0/ 0/ 1	1/ 0/ 2	0/ 0/ 1
Canoga Park					*1/ 0/ 0
TOTAL	2/ 1/98	3/ 3/101	1/ 4/130	2/ 2/ 96	*1/ 4/103

Includes NASA fatalities, permanent disabilities, hospitalization of 5 or more persons, lost time mishaps and Type A, B, & C property damage according to NMI 8621.1F.

* Northridge Earthquake. See Page 34 for details.

NASA TYPE A, B, AND C MISHAPS

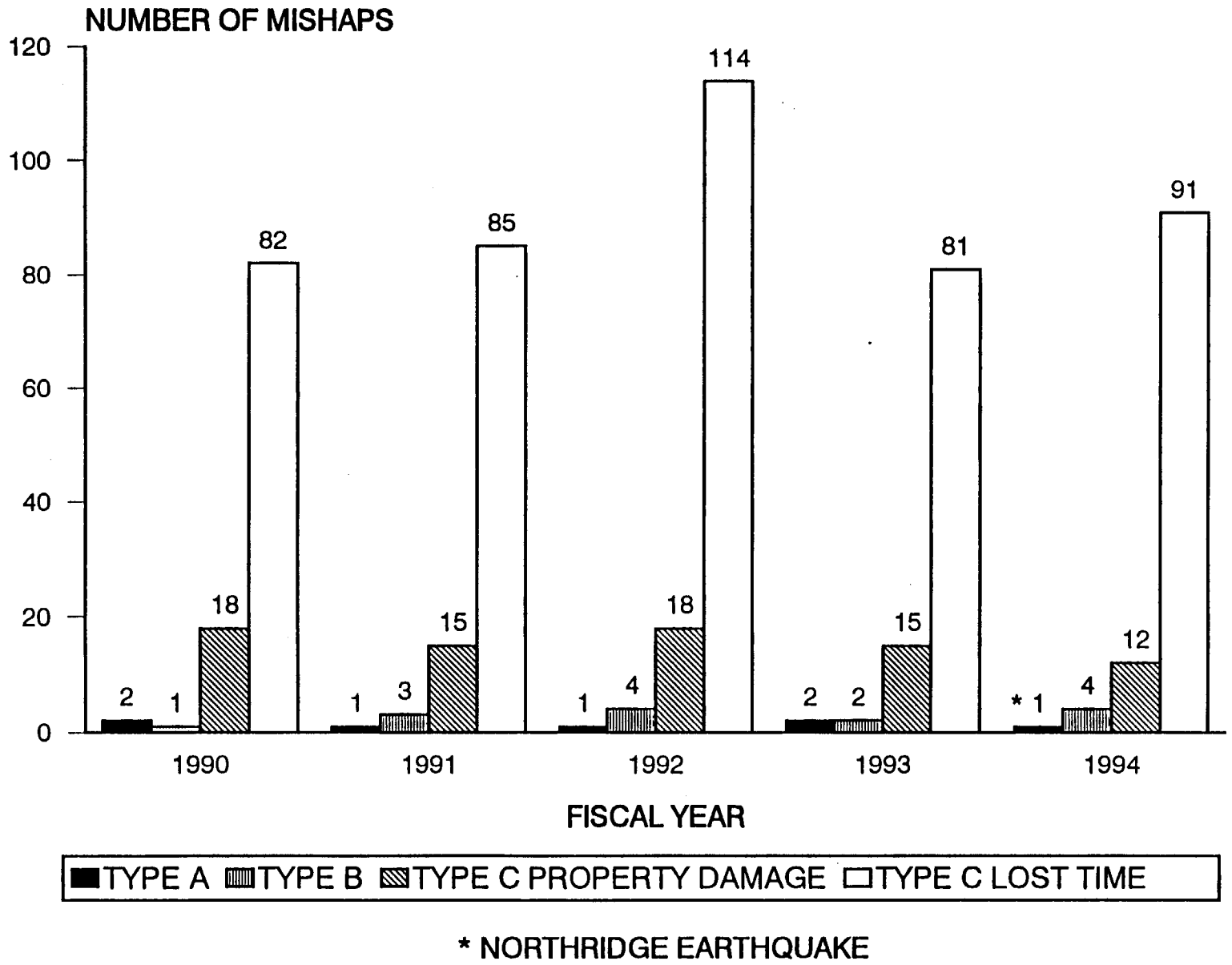


Figure 14

TABLE 5A. PERFORMANCE SUMMARY - ANNUAL REPORT FY 1994

NASA LOST TIME RATES

	1993	1994	GOAL 1994
ARC	0.74	1.08	0.51
DFRC	1.53	0.22	0.74
GSFC/WFF	0.28	0.42	0.36
HQ	0.30	0.39	0.54
JSC/WSTF	0.27	0.28	0.36
KSC	0.21	0.48	0.34
LARC	0.26	0.20	0.34
LERC	0.30	0.61	0.40
MSFC	0.35	0.29	0.42
SSC	0.84	0.50	0.34
NASA	0.35	0.43	0.40

TABLE 5B. PERFORMANCE SUMMARY - ANNUAL REPORT FY 1994

	TYPE A MISHAPS			TYPE B MISHAPS		TYPE C MISHAPS		MATERIAL LOSSES	
	1993	1994	(FATALITIES) 1994	1993	1994	1993	1994	1993	1994
ARC	0	0	0	0	1	12	19	0	414,500
DFRC	0	0	0	0	0	9	1	0	17,370
GSFC/WFF	0	0	0	1	1	10	13	1,131,200	0
HQ	0	0	0	0	0	7	10	4,656	24,777
JPL	1	0	0	0	0	1	1	* 54,774	155,500
JSC/WSTF	0	0	0	0	1	13	9	298,411	710,941
KSC	0	0	0	0	0	8	11	483,449	59,862
LARC	0	0	0	0	1	9	9	80,000	914,000
LERC	0	0	0	1	0	9	17	751,103	130,881
MSFC	0	0	0	0	0	16	12	306,366	519,052
SSC	1	0	0	0	0	2	1	3,125,000	3,000
TOTALS	2	0	0	2	4	96	103	* 6,234,959	2,949,883
Canoga Park		**1							**10,000,000

* Does not include loss of the Mars Observer spacecraft.
** Earthquake damage at Canoga Park. See Page 34 for details.

MAJOR MISHAPS

FY 1994

NORTHRIDGE EARTHQUAKE
CONTRACTOR
TYPE A

Rocketdyne facilities in Canoga Park, California, sustained significant damage on January 17, 1994, resulting from an earthquake, having a Richter scale magnitude of 6.7. The main shock (epicenter) was located approximately one mile south of the Northridge District of the City of Los Angeles and approximately 3 miles from the Rocketdyne facility. There were no personnel injuries at the plant. Numerous cracks were found in facility structures, but all remained standing. A number of water pipes were damaged, including portions of the fire protection system, resulting in water damage to buildings and equipment. Some minimal damage was sustained to Space Shuttle Main Engine hardware. NASA repair costs were estimated at $10,000,000.

3.5 FOOT HYPERSONIC WIND TUNNEL
CERAMIC BED MATRIX HEATER MISHAP
AMES RESEARCH CENTER
TYPE B

On January 27, 1994 at approximately 10:00 a.m. a mishap occurred at the 3.5 Foot Hypersonic Wind Tunnel causing significant damage to the Ceramic Bed Matrix Heater. Damage was confined to the interior of the heater vessel, the Mach 5 nozzle, and the diffuser. There were no personnel injuries. The mishap occurred at the start of a scheduled cold-flow blowdown test that was a part of an Integrated Systems Test (IST) procedure. The purpose of this IST was to bring the facility back on line following a Construction of Facilities project that included major modification and rehabilitation of the heater system. The tests in progress at the time of the mishap were in the early phases of the IST, and were for the purpose of verifying operation of safety devices and circuits. On the day of the mishap, four similar tests had been run without incident. At the start of the fifth test, personnel in the control room heard and felt a large "thump" that shook the facility. Emergency shutdown procedures were implemented, followed by visual inspection of the facility. Subsequent investigations determined that the ceramic bed matrix of the heater had lifted and impacted the vessel wall brick. Pieces of broken brick had been entrained in the air stream and carried through the nozzle to impact on the back wall of the diffuser chamber. The primary cause of the mishap was an incorrectly located pressure port near the bottom of the heater vessel. This pressure port was a primary input sensor for control of air flow into the heater, and its incorrect placement caused significant underestimates of differential pressure across the bed. IST data indicated that flow conditions produced a great enough differential pressure to lift the ceramic bed. The repair cost of this mishap was estimated at $414,500.

WAREHOUSE FIRE
LANGLEY RESEARCH CENTER
TYPE B

At approximately 5:35 p.m. EST, Thursday, December 30, 1993, there was a fire at the Langley Research Center's Environmentally Controlled Warehouse, Building 1249. The facility was not occupied at the time of the fire. The fire was extinguished by NASA Fire Department Station 8, with assistance from other City of Hampton Fire Department units. There were no personal injuries, but the facility was damaged beyond repair and the contents lost. The cause of the fire was determined to be a faulty window air conditioning and heating unit. The investigation board concluded that a faulty resistance heater in the unit ignited an internal ducting shroud that was made of a flammable plastic. The cost of this mishap was determined to be $622,000.

ELECTRIC CIRCUIT BREAKER PHASES REVERSED
JOHNSON SPACE CENTER
TYPE B

An AMDAHL 5995 2550M mainframe computer was damaged when it overheated on May 16, 1994, in the Software Production Facility (SPF) at the Johnson Space Center. Preventive maintenance of electrical power equipment was performed during a planned power outage over the weekend of May 13 - 15. A 3-phase 225 amp circuit breaker was removed for testing from a mechanical room adjacent to the SPF. Upon completion of successful testing of the breaker, it was reinstalled; but two of the output wires were interchanged resulting in a phase reversal of the electric power to the circuit downstream of the breaker. The reverse phase power caused cooling fans to turn backward providing insufficient air flow to the computer. The computer was in a reverse phase power environment for 45 - 50 minutes. Computer anomalies and poor air flow and overheating symptoms were observed during this period. The astute response by a passing electrician led to the identification of the phase reversal problem, shut down of the computer, and identification of the miswired circuit breaker. The overheating damaged or caused suspected damage to 61 circuit boards. The primary cause of this mishap was the miswiring of the circuit breaker. There were several contributing causes including inadequate procedures and drawings for the preventative maintenance on the circuit breaker panel, no written equipment power up procedures, and inadequate training on SPF equipment and systems. The cost of physical damage to the computer was $499,000.

PERMANENT EYE INJURY
GODDARD SPACE FLIGHT CENTER
TYPE B

An employee sustained a permanent injury when he was struck in the eye by a metal chip. While removing the Spartan 204 instrument from its test structure, a bushing on one of the mounts pulled out of its normal seated position, blocking the removal of the instrument. The nature of the assembly made access to the bushing difficult. One person used a hammer and punch to reseat the bushing while a second person watched through a small gap to monitor its progress. After several hammer blows, the observer was struck in the eye by a metal chip. He was taken to the Center health unit and later had the lens removed from his eye. The primary cause of the mishap was conducting a hazardous operation without using the appropriate protective equipment. Misjudgement of conditions was a contributing factor.

TYPE C MISHAPS
EQUIPMENT/PROPERTY DAMAGE

Jet Propulsion Laboratory
Buildings at JPL sustained cosmetic and minor structural damage as a result of the Northridge Earthquake. The cost of repairs was estimated at $150,000.

Johnson Space Center
While testing an electrical generator, a ground fault occurred causing damage to the power current transformers. Investigation reveled that the insulation for one phase of the generator's stator had deteriorated. The primary cause of the mishap was material failure. Final cost of the mishap was $122,000.

Langley Research Center
An antenna heat shroud was damaged when the antenna heater exploded. Due to the winter weather, there was a buildup of snow on the heaters. The explosion occurred following trouble-shooting procedures when an attempt was made to relight the heaters. The primary cause of the mishap was the misjudgment of conditions that allowed fuel and oxidizer near an ignition source. The final cost of the mishap was $30,000.

Test pad model instrumentation at the 8-Foot High Temperature Tunnel was damaged when failed tubing allowed water into the Electronically Sensed Pressure (ESP) module reference. 27 ESP modules were damaged as a result. The primary cause of the mishap was equipment failure due to a design deficiency. A lack of proper procedures and requirements was a contributing factor. Final cost of the mishap was $125,000.

A National Aero-Space Plane model was damaged during an operation in the 8-Foot High Temperature Tunnel. The hydraulic system was being set up in preparation for a force measurement system calibration. 4"x4" wood blocks had been placed under the model starter panel leading edge to facilitate post-run inspections. When the hydraulic system was activated, the starter panel was forced to impinge on the wood blocks resulting in damage to the leading edge. The final cost of the mishap was $25,000.

A NASA jet airplane sustained damage when a fuel control valve failed during engine shutdown procedures resulting in a tail-pipe fire. Standard emergency procedures resulted in an engine re-start due to rising temperatures and the lingering presence of fuel. The emergency fuel cut-off valve eventually extinguished the fire, but not before significant temperatures above design allowables had occurred. The primary cause of the mishap was equipment failure due to material failure. The cost was estimated at $100,000.

Lewis Research Center

An electrical power outage occurred when a 34,500 volt cable failed. The primary cause of the mishap was equipment failure due to material failure. Repair costs were estimated at $34,000.

A large current transformer owned by the Cleveland Electric Illuminating Company and located at a LeRC electrical substation catastrophically failed. Damage was sustained to portions of LeRC's 138,000 volt line. The cost of repairs was estimated at $55,000.

A safety relief valve on a central heating and air conditioning purge pump failed resulting in the release of approximately 7,000 pounds of Freon. The primary cause of the mishap was equipment failure due to material failure. The cost of the mishap was estimated at $29,000.

Marshall Space Flight Center

A 10 meter Tower Initialization Reference Fixture (TIRF) lens fractured during an ion figuring operation designed to remove surface irregularities from the highly polished optical lens surface by bombarding the surface in a vacuum with highly accelerated neutral particles. Glass pieces released from the fracture impacted the ion source in the figuring chamber and the machine's automatic controls shut the system down. The investigation concluded that the fracture was initiated at a pre-existing external flaw located at the interface of the lens outer diameter and the beveled edge most likely caused by a minor abrasion during handling or installation into the ion figuring chamber. The cost of the mishap was estimated at $50,000.

Excessive oxidizer leakage was noted during post test inspections of a Space Shuttle Main Engine. The leakage was isolated to the Fuel Preburner Oxidizer Valve (FPOV). Further inspection found the FPOV ball seal to be cracked through. Also, the High Pressure Fuel Turbo Pump Shaft travel was found to be less than baseline. The valve and pump were returned to the manufacturer for disassembly and inspection. The primary cause of this test failure was equipment failure due to material failure. The final cost was $200,000.

A Solid Rocket Motor aft segment was damaged during a lifting operation. The segment was being rotated into the vertical position when the clevis end of the case struck the north end bridge of the 27-ton crane being used in the operation. The immediate cause of the mishap was the lack of clearance. Misjudgement of conditions and lack of procedures were contributing factors. The final cost of the mishap was $164,670.